COLORADO
DISASTER
RECOVERY

LESSONS LEARNED

A GUIDE TO PLAN, REACT, ADAPT, EVOLVE,
AND ACHIEVE THE BEST POSSIBLE OUTCOMES
FOR OUR COMMUNITIES AND STREAM
CORRIDORS

NFFA Webinar: Disaster Recovery Lessons Learned. May 12, 2020
Authors: Jeff Sickles, Katie Jagt, Michael Blazewicz. Some rights reserved.
A WATERSHED APPROACH

BACKGROUND ON COLORADO’S RECOVERY PROGRAM
THE FLOOD OF 2013
WATERSHED BASED FLOOD RECOVERY

• Protect life and property while restoring ecological processes that connect land and water
• Complete recovery work on a watershed scale
• Support early planning to identify root issues, develop holistic solutions, and allow time to secure appropriate funding

• Support watershed coalitions as a model for stakeholder engagement
• Execute projects with multiple objectives
• Incorporate resiliency into every project
RECOVERY: BY THE NUMBERS

- **117** total flood recovery projects completed (68 EWP)

- Total construction costs of over **$70 million** (~$50 million EWP)

- Over **$270 million** – value of infrastructure and private structures protected

- **65 miles** of river and floodplain improvements implemented (40 miles EWP)

- **12** watershed master plans finalized

- **34** resiliency planning studies completed

- **23** comprehensive recovery planning studies completed

- Over **700** private property owners engaged

- **$4.2 million** across 10 coalitions for capacity building staffing grants. CWCB supplemented this with an additional $400,000.

*These are numbers for the CWCB and DOLA led recovery efforts for the 2013 flood.*
HOW AND WHY OF LESSONS LEARNED

• Recommendations that will allow state and federal disaster response programs to implement more resilient and holistic recovery actions (noted as Recommendations for Changes to State and Federal Disaster Response).

• Actions to implement immediately after a disaster has occurred (noted as Recommendations for Disaster Recovery Actions).

• Action items that can be completed by a community ahead of the next disaster (noted as Recommendations for Pre-Disaster Actions).
Recommendations for Pre-Disaster Actions:

- Invest in developing personal relationships with state and federal partners. Knowing federal program managers on a first name basis and having a high degree of trust with them can make a huge difference during funds recovery.

- Develop leadership responsibilities and organizational structures to identify disaster types, (i.e. wildfires or flooding, on a state or regional basis). This structure will establish how funding will be distributed and which agency will set the vision and overall goals and objectives of the recovery effort and allow recovery efforts to hit the ground running when disaster strikes.

- Invest in and allow for longer timelines for recovery project development and construction. Longer timelines can improve outcomes by allowing for the proper setting of alternatives, public outreach and communication, and expanded partnerships for funding and multiple benefits. Longer timeline also provide a better opportunity to resolve unforeseen and length permitting processes that might otherwise create significant challenges to project implementation.

- Develop state and local planning and management processes that allow provinces and community projects and programs to be eligible for federal assistance.

- Leadership should be prepared to encourage and resolve conflicts that arise from federal, state and local agencies, which may have different priorities in terms of projects and to execute the holistic recovery vision.

- The lead agency should recognize and establish a single technical assistance role with expertise in food management and their processes to guide recovery across agencies and funding programs.

- The lead agency should encourage local groups, coalitions and local governments to work together. Often times these groups have pre-established relationships within the impacted communities. Therefore, they understand local values and are already established in close proximity to the need.

- The lead agency should develop a culture of collaboration with a vision of raising the standard of performance within the local engineering, design, and construction industry. There can be significant disruption and delays on the front end of large collaboration efforts. Ultimately, the objective must be to create strong partnerships, focused on the goal of achieving the best possible outcome on implemented projects. In other words, professionals need to work across disciplines and in collaboration with competitors to ensure that no opportunity is left behind.
ORGANIZING FOR RECOVERY

WITH ORGANIZATION COMES EMPOWERMENT
DEVELOP A CENTRALIZED RECOVERY PROGRAM THAT CAN SUPPORT A COMPREHENSIVE VISION

1. Reduce Hazards and Protect Life Safety and Property
2. Use Federal and State Funding Effectively
3. Enhance the Health and Resilience of Watersheds and Stream Corridors
4. Build Capacity of Watershed Coalitions
5. Advance a Watershed Approach to Flood Recovery
ORGANIZING FOR RECOVERY

The Human Element
- Communication
- Stakeholders
- Training

Pre-Disaster Planning
- Multi-Hazard Risk Identification
- Pre-Disaster Agreements

Disaster Response
- Emergency Actions
- Bring Together Technical Experts
- Post Disaster Data Collection and Analysis

Recovery Planning
- Shared Corridors
- Locally Led Plan
- Evaluate Buyouts
- Project Scoping and Prioritization

Design and Permitting
- Funding for Design
- Design Strategies and Standards
- Quality Assurance and Quality Control
- Infrastructure and Resiliency Permitting
- Floodplain Management

Monitoring and Adaptive Management
- Monitoring
- Adaptive Management

Implementation
- Construction Oversight
- Standard Specifications and Invoicing
- Construction Procurement
- Planning for Revegetation
- Plant Installation
- Revegetation Maintenance

Centralized Recovery Program

Pre-Disaster Planning

Graphic: Conceptual Model for Disaster Recovery. The figure above is representative of the disaster recovery process implemented by the Colorado Water Conservation Board and Colorado Department of Local Affairs following the 2013 flood.
MAXIMIZE THE BENEFIT OF FEDERAL FUNDING THROUGH CENTRALIZED LEADERSHIP AND ORGANIZATION
MAXIMIZE THE BENEFIT OF FEDERAL FUNDING THROUGH CENTRALIZED LEADERSHIP AND ORGANIZATION

OPPORTUNITIES

• Creates a program Technical Assistance team to support program management, design, construction oversight, and QA.
• Set program expectations, e.g. get away from overly restrictive design requirements that are inappropriate for stream rehabilitation (e.g. 100% design)

RESPONSIBILITIES

• Provides funding and program oversight, such as environmental compliance
• Sets the recovery vision
• Provides partial match funding
• Sets guidelines and standards
• Communication with local stakeholders
• Oversees project implementation
• Raises local match
• Commits to O&M

ORGANIZING FOR RECOVERY
AUTHORIZE STATE AND LOCAL RECOVERY FUNDING

- Get people working
- Keep local disaster recovery money as flexible as possible
- Use local funding for recovery plans
- Leverage local dollars for construction match
Funding for master planning was made available via CWCB.

Move watershed coalitions and communities towards prioritization and implementation of recovery projects:

- Reduced flood and geomorphic hazards
- Improved ecological conditions

The master plans defined each watershed’s vision for recovery and enhanced the community’s understanding of the river corridor and associated risks.
A TALE OF TWO RECOVERY PROGRAMS
DISASTER RESPONSE

GUIDING EMERGENCY EFFORTS TOWARDS RESILIENT LONG-TERM OUTCOMES

+ 

SHARED CORRIDORS

RIVERS, ROADS, AND RESIDENCES
Getting the foundation for a successful long-term design set immediately after the flood in the emergency response actions is imperative for recovery success.
WHAT DO STREAMS LOOK LIKE IMMEDIATELY FOLLOWING A FLOOD?

Big Thompson River, Drake, Colorado

DISASTER RESPONSE & SHARED CORRIDORS
AND WHY DO THEY LOOK SO DIFFERENT A FEW MONTHS LATER?
REFRAME THE FLOOD: From a “river problem” to a “human problem”
THE 2013 FLOOD RESPONSE REFRAMED

- Large Wood and Small Wood Debris Jam
- Depositional Area—Not Erosional!
- Side Channel
- Cutoff Chutes and Side Channels Destroyed
- Riprap to halt erosion
- Tyranny of the Single Thread
- Large Wood and Small Wood Gone

DISASTER RESPONSE & SHARED CORRIDORS
POST-FLOOD EMERGENCY REPAIRS
Negative Ecosystem Impacts:
CPW POST-FLOOD
Fish Survey Data

South Fork St. Vrain Creek, Bohn Park, October 2013. Post-flood survey estimated 1,185 trout per mile, a notable decrease but not a complete collapse of the fishery.

South Fork St. Vrain Creek, Bohn Park, February 2014. Post-channelization survey estimated 9 trout per mile, a complete collapse of the trout fishery.

DISASTER RESPONSE & SHARED CORRIDORS
Streams need space to accommodate their energy and sediment.
Conceptual Model of Energy Continuity
Conceptual Model of Energy Continuity: Channelized
Shared Corridors: Consider the difference between addressing a problem and transferring a problem.
Colorado Disaster Recovery: Lessons Learned

County Road 43
Larimer County—FHWA project

Managing Infrastructure in the Stream Environment

Advisory Committee on Water Information
Subcommittee on Sedimentation Environment and Infrastructure Working Group

Prepared by:
Joel S Sholtes1, Caroline Ubing1, Timothy J Randle1, Jon Fripp1, Daniel Cendrell2, and Drew C Baird1

1: Bureau of Reclamation, Technical Services Center, Sedimentation and River Hydraulics Group, Denver, Colorado
2: Natural Resources Conservation Service, National Design, Construction, and Soil Mechanics Center, Fort Worth, Texas
3: U.S. Forest Service, National Stream and Aquatic Ecology Center, Fort Collins, Colorado

Box 1.—Big Thompson River—U.S. Highway 34 Improvements

After a devastating flood in 2013, the Colorado Department of Transportation repaired and re-built a canyon-bound highway. Many portions of the highway were washed out, especially where the road ran along the outside of river bends (right). The highway was elevated above and moved away from one such high hazard area as part of the post-flood reconstruction. Other resilient designs include setbacks from the river, vegetated floodplain benches, and integration of vegetation into embankments. Though costly, these improvements reduce the risk of future damage and the economic costs of losing a major transportation corridor from the next flood.
DISASTER RESPONSE & SHARED CORRIDORS
Disaster Response and Shared Corridors

TEMPORARY BECOMES PERMANENT
FLOOD RECOVERY PLANNING
VALUES, GOALS, AND OBJECTIVES
**Watershed Zone Stream Description**

**Canyons**
- **Pre-Flood:** Stream is located in headwater or confined valley, frequently adjacent to roads and homes. Stream is in quasi-equilibrium state and typically has higher transport and stream power.
- **Post-Flood:** Significant damage with new flow paths, debris flows, large sediment deposition.
- **Future:** A wider stream corridor for stream movement. Rip-rap is replaced with natural sediments like large wood, providing structure and improvement of riparian habitat.

**Alluvial Fan**
- **Pre-Flood:** Partly confined stream with moderate channel grade and low sinuosity. Homes adjacent to stream bank and in floodplain. Stream has moderate channel grade and low sinuosity.
- **Post-Flood:** Stream migrated significantly and deposited large amounts of sediment.
- **Future:** Floodplain is free of major development allowing normal riparian habitat development with secondary channels used to help transport future high flows.

**High Plains**
- **Pre-Flood:** Low grade stream is typically unconfined with adjacent floodplains or entrenched with adjacent houses and agricultural land. Stream is single thread and straightened in some areas, and bridges are common.
- **Post-Flood:** Stream exceeded channel capacity, damaging roads and depositing trash and other debris.
- **Future:** Additional room for the stream and channel capacity, invasive species will be removed and normal channel evolution occurs with bars, riffles, and pools.

**Conceptual Model for Left Hand Creek Watershed**
PROJECT IDENTIFICATION AND SCOPING

LAYING THE FOUNDATION FOR SUCCESSFUL RECOVERY
<table>
<thead>
<tr>
<th>TA Team Rank</th>
<th>Applicant</th>
<th>Watershed Coalition</th>
<th>Project Type</th>
<th>Coalition Rank</th>
<th>Project Cost</th>
<th>Notes</th>
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<tr>
<td>1</td>
<td>Big Thompson River Restoration Coalition</td>
<td>Big Thompson</td>
<td>Habitat, hydraulic, floodplain improvement, bank stabilization, geomorphic risk</td>
<td>1 of 1</td>
<td>$296,791</td>
<td>Fund project as proposed</td>
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<td>1</td>
<td>Coal Creek Canyon Watershed Partnership</td>
<td>Coal Creek</td>
<td>Debris, erosion, bank restoration</td>
<td>1 of 1</td>
<td>$177,604</td>
<td>Fund to fill $300,000 and extend the project length</td>
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<td>Fourmile Watershed Coalition</td>
<td>Fourmile</td>
<td>Revegetation, restoration</td>
<td>2 of 4</td>
<td>$72,379</td>
<td>Use $64,898 and BoCo to design build the project originally identified as the SB-179 project (before the money)</td>
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<td>Fourmile Watershed Coalition</td>
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<td>Debris, erosion, bank restoration</td>
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<td>$227,521</td>
<td>Examine these two Lefthand Projects and determine if they can be completed for a total of $300K</td>
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<td>James Creek Watershed Initiative</td>
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<td>$299,882</td>
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<td>Lefthand Watershed Oversight Group</td>
<td>Lefthand</td>
<td>Debris, Floodplain, Channel</td>
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<td>$298,739</td>
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<td>Fountain Creek Watershed, Flood Control and Greenway District</td>
<td>Upper Fountain Creek/Cheyenne Creek Coalition</td>
<td>LID demonstration project on Cheyenne creek</td>
<td>1 of 1</td>
<td>$290,000</td>
<td>Fund project as proposed</td>
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<td>Estes Valley Watershed Coalition</td>
<td>Estes Valley</td>
<td>Wetland restoration, riprap, channel reshaping</td>
<td>1 of 1</td>
<td>$267,500</td>
<td>Fund project as proposed</td>
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<td>Little Thompson Watershed Restoration Coalition</td>
<td>Little Thompson</td>
<td>Restoration, stabilization, mitigation</td>
<td>1 of 1</td>
<td>$299,200</td>
<td>See TA notes on how to allocate funds if not all 6 sites are construction ready</td>
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<td>1</td>
<td>Town of Lyons</td>
<td>St. Vrain</td>
<td>Bank restoration</td>
<td>3 of 3</td>
<td>$278,218</td>
<td>Increase fund request to $300,000 and ask that Lyons extend upstream of town boundary to old south st. vrain bridge (see TA notes)</td>
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**Subtotal:**

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<tr>
<th>TA Team Rank</th>
<th>Applicant</th>
<th>Watershed Coalition</th>
<th>Project Type</th>
<th>Coalition Rank</th>
<th>Project Cost</th>
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<tr>
<td>2</td>
<td>Town of Lyons</td>
<td>St. Vrain</td>
<td>Bank restoration</td>
<td>?</td>
<td>$300,000</td>
<td>Recommend this project be partially funded for channel work only at $75M and combined with SB-179 fund project</td>
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<td>2</td>
<td>Lefthand Watershed Oversight Group</td>
<td>Lefthand</td>
<td>Public engagement, engineering design, weed management</td>
<td>High</td>
<td>$264,238</td>
<td>Consider partial funding for further debris removal and revegetation</td>
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<td>2</td>
<td>City of Longmont</td>
<td>St. Vrain</td>
<td>Revegetation, stream restoration, diversion, culvert</td>
<td>?</td>
<td>$150,000</td>
<td>Consider funding reveg only</td>
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<td>2</td>
<td>Boulder County</td>
<td>Fourmile</td>
<td>Stabilization, debris rack</td>
<td>1 of 4</td>
<td>$260,313</td>
<td>Request revised proposal to innovate debris rack design and install a demonstration project. Do not fund for channel armoring as proposed. Consider $500,000 in matching funds</td>
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**Subtotal (Flexible):**

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<th>Project Type</th>
<th>Coalition Rank</th>
<th>Project Cost</th>
<th>Notes</th>
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<td>3</td>
<td>Boulder County</td>
<td>St. Vrain</td>
<td>Breach closure, stabilization</td>
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<td>$300,000</td>
<td>Combine into planning/implementation project in round 2</td>
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<td>St. Vrain</td>
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<tr>
<td>Big Thompson</td>
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<td>Habitat, hydraulic, floodplain improvement, bank stabilization, geomorphic risk</td>
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<td>Fund project as proposed</td>
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<tr>
<td>Coal Creek</td>
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<td>Fund to fill $300,000 and extend the project length</td>
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<td>Revegetation, restoration</td>
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<td>Fund Logan Mill Project. Coordinate with CWCB and BoCo to design build the project originally identified as the SB-179 project before the money was turned into road planning funds.</td>
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<td>Restoration</td>
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<td>Examine these two Lethand Projects and determine if they can be completed for a total of $300K</td>
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<td>Estes Valley</td>
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<td>LID demonstration project on Cheyenne creek</td>
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<td>Fund project as proposed</td>
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<td>St. Vrain</td>
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<td>Wetland restoration, riprap, channel management</td>
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<td>Fund project as proposed</td>
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<tr>
<td>St. Vrain</td>
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<td>Restoration, stabilization, mitigation</td>
<td>1 of 1</td>
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<td>See TA notes on how to allocate funds if not all 5 sites are construction ready</td>
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<td>St. Vrain</td>
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<td>Bank restoration</td>
<td>3 of 3</td>
<td></td>
<td>Increase fund request to full $300,000 and ask that Lyons extend upstream of town boundary to old south st. Vain bridge (see TA notes)</td>
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<td>St. Vrain</td>
<td></td>
<td>Bank restoration</td>
<td>?</td>
<td></td>
<td>SUBTOTAL</td>
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<td>St. Vrain</td>
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<td>Public engagement, engineering design, wood management</td>
<td>High</td>
<td></td>
<td>Recommend this project be partially funded for channel work only at $75/ft and combined with SB-179 fund project</td>
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<td>St. Vrain</td>
<td></td>
<td>Revegetation, stream restoration, diversion, culvert</td>
<td>?</td>
<td></td>
<td>Consider partial funding for further debris removal and revegetation</td>
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<tr>
<td>Fournile</td>
<td></td>
<td>Stabilization, debris rack</td>
<td>1 of 4</td>
<td></td>
<td>Consider funding reveg only</td>
<td></td>
</tr>
<tr>
<td>St. Vrain</td>
<td></td>
<td>Breach closure, stabilization</td>
<td>?</td>
<td></td>
<td>Request revised proposal to innovate debris rack design and install a demonstration project. Do not fund for channel armoring as proposed. Consider funding for culvert removal and installation of a low water road crossing as has been used in other fire burned areas.</td>
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<td>Fournile</td>
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<td>Stream restoration design</td>
<td>3 of 4</td>
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<td>Consider for Round 2 after further design/budget development</td>
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<td>Stream restoration design</td>
<td>?</td>
<td></td>
<td>Consider for Round 2 after further design/budget development</td>
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</table>
CONSTRUCTION

MAKING THIS OPPORTUNITY COUNT
CONSTRUCTION
Upper Coal Creek Improvements Project
Weekly Construction Update

Date: 04/29/2017
By: Mark Schutte
Location: Coal Creek Canyon, Jefferson County, CO.

PROJECT SPONSOR: Coal Creek Canyon Watershed Partnership

Work In Progress
Completed all improvements on Lowe property
1. Excavation and installation of two low benches with void-filled riprap back slopes.
2. Boulder toe installation completed between channel and low bench areas.

Began soil removal efforts on Simonetti property.

Upcoming Work
1. Mobilize to Cameron property and begin channel improvements.
2. Continue soil removal on Simonetti property.
3. Revegetation work on Adair and Khachatryan properties.

Other Notes
1. A larger crew will be on-site in the coming weeks to speed up revegetation.
2. Contractor will protect sites with additional erosion control if necessary in preparation for precipitation over the weekend.
CONSTRUCTION
## Periodic Estimate for Partial Payment
### Summary and Approvals

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### Task 2 - Earthwork and Grading

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**Note:**
- Task Subtotal: $3.00 $6.00 $0.00
- Task 2 Subtotal: $3.00 $6.00 $0.00

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**CONSTRUCTION**
### Flood Recovery Project Monitoring Methods

**Mark Beardsley and Brad Johnson**  
**March 7, 2018**

#### Field-acquired aerial imagery

- Small aerial surveys are routine for monitoring, especially for restoration, in unconfined systems, in-channel structures, and water quality issues. They can be used to measure qualitative attributes, track macroinvertebrate biomass and riparian vegetation. Aerial images are high-resolution thermal, optical imaging, and can be scheduled for specific dates.

- Orthomosaics are very helpful to enable quantitative measures and to ensure that conditions are intact.

#### Observations

- **Field Vegetation:**
  - Tree species and cover
  - Shrub species and cover
  - Herbaceous species and cover

- **Soil Erosion:**
  - Erosion patterns
  - Soil type

- **Stream Morphology:**
  - Channel width
  - Depth
  - Gradient

- **Flow Characteristics:**
  - Flow velocity
  - Flow depth

- **Water Quality:**
  - Temperature
  - Dissolved oxygen

- **Fish and Benthic Invertebrates:**
  - Species composition
  - Abundance

#### Monitoring and Adaptive Management
PRE-DISASTER PLANNING

PREPARING FOR THE FUTURE
Pre-Disaster Planning
Roles and Relationships
Adequately identify all hazards in the corridor.
Pre-identify Project Areas (i.e., response zones)
PLANNING FOR FLUVIAL HAZARDS

QUICK START GUIDE FOR COMMUNITIES

Planning for fluvial hazards is an essential component of stream corridor management and the prevention of future flood damages, as damage to structures located outside of FEMA floodplains has been a common occurrence due to flows and/or floodplain erosion. The following are some proactive actions and best practices a community can implement in conjunction with Fluvial Hazard Zone mapping to reduce threats to life and property from fluvial hazards in their stream corridors.

FLUVIAL HAZARD ZONE MAPPING

Fluvial processes become hazardous when an adjacent stream channel threatens public infrastructure, homes, businesses, and other investments. In order to address the unrecongnized hazards associated with erosion, sediment deposition and other dynamic river processes, the CWCB has developed a program to identify and map the hazards posed by these natural river processes and develop tools to help communities and landowners better understand the hazards associated with flood events.

Fluvial hazard mapping is a component of the Colorado Hazard Mapping Program (CHMP) funded under the Colorado Water Conservation Board in partnership with the Colorado Geological Survey, the Colorado Department of Local Affairs, and local governments. The CHMP program is working toward effective long-term flood hazard reduction in Colorado through the development of HZ mapping protocols and updates to the HZ assessment in combination with traditional floodplain mapping.

More information and FAQs about fluvial hazard zone mapping please visit www.ColoradoFHZ.com

www.ColoradoFHZ.com
RECOVERY RESOURCES

HIT THE GROUND RUNNING
RECOVERY RESOURCES  www.ColoradoEWP.com
THANK YOU

Questions?
Jeff Sickles, Enginuity
jsickles@enginiuity-es.com
Katie Jagt, Watershed Science & Design
katiejagt@watershedscienceanddesign.com
Michael Blazewicz, Round River Design
michael@roundriverdesign.com